Predictors of adverse outcomes on an acute geriatric rehabilitation ward

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Abstract

Background: multidisciplinary rehabilitation is of proven benefit in the management of older inpatients. However, the identification of patients who will do well with rehabilitation currently lacks a strong evidence base.

Objectives: the aims of this study were to compare the importance of chronological age, gender, co-morbidities and frailty in the prediction of adverse outcomes for patients admitted to an acute geriatric rehabilitation ward.

Design: prospective observational cohort study.

Subjects and setting: two hundred and sixty-five patients admitted consecutively to an acute geriatric rehabilitation ward at a tertiary care teaching hospital.

Methods: frailty status was measured by an index of accumulated deficits, giving a potential score from 0 (no deficits) to 1.0 (all 40 deficits present). Patients were stratified into three outcomes: good (discharged to original residence within 28 days), intermediate (discharged to original residence but longer hospital stay) and poor (newly institutionalised or died).

Results: patients were old (82.6 ± 8.6 years) and frail (mean frailty index (FI) 0.34 ± 0.09). Frailty status correlated significantly with length of stay and was a predictor of poor functional gain. The odds ratio of intermediate and poor outcome relative to a good outcome was 4.95 (95% CI = 3.21, 7.59; P < 0.001) per unit increase in FI. Chronological age, gender and co-morbidity showed no significant association with outcomes.

Conclusion: frailty is associated with adverse rehabilitation outcomes. The FI may have clinical utility, augmenting clinical judgement in the management of older inpatients.

Keywords: frailty index, co-morbidity, aged, hospitals, rehabilitation, elderly

Introduction

Comprehensive geriatric assessment (CGA) and multidisciplinary rehabilitation are of proven benefit in the management of older inpatients [1, 2]. However, the identification of patients who will do well with rehabilitation, and those at risk of adverse outcomes, currently lacks a strong evidence base.

Previous studies investigating predictors for functional recovery in older people have tended to focus on single events such as hip fracture [3] or stroke [4] or on specific groups of patients, such as those with cognitive impairment [5–7]. Evidence is limited regarding predictors of outcome of rehabilitation programmes for older patients with complex problems; patients often described as ‘frail’. While the importance of frailty with respect to the presentation of acute illness in older people has long been recognised [8], the impact of frailty on rehabilitation outcomes has not yet been reported. The aims of this study were to compare the importance of chronological age, gender, co-morbidities and frailty in the prediction of adverse outcomes for patients admitted to an acute geriatric rehabilitation ward.
Methods

Setting and sample

This was a prospective observational cohort study of patients admitted to an acute geriatric medicine rehabilitation unit at the University Hospital of Wales, Cardiff between February and October 2008.

Inclusion criteria included admission related to geriatric syndromes, predicted discharge to usual place of residence within 28 days and the need for multidisciplinary rehabilitation. Exclusion criteria included severe dementia (patients unable to communicate basic needs or perform activities of daily living due to their dementia) [9]; acute stroke; chronically bed-bound patients and those with an expected survival of less than 6 weeks.

Measures

All patients were reviewed on admission by a single geriatrician (IS) with experience of the clinical care of vulnerable older people and training in the use of specific measurement tools. Co-morbid conditions were measured using the Charlson co-morbidity index [10].

Frailty

Upon admission, a frailty index (FI) was determined for each participant, employing a well-defined methodology [11]. Valid frailty indices can be constructed from different numbers and types of variables providing certain criteria are fulfilled [12]. ‘Deficits’ should cross a range of systems (hence 30 cognition-related variables would not constitute a FI), accumulate with age (e.g. ischaemic heart disease but not congenital heart disease), not become ubiquitous with age (hence presbyopia would be excluded) and be associated with adverse outcomes (thus greying hair would not be considered a deficit) [11]. For our cohort, component variables of the FI were co-morbidities (a maximum of 15), dependence in activities of daily living (up to 10 deficits), number of medications (on a graded scale to 5) and one deficit for each of the following: three or more falls in the preceding year, timed up-and-go of 9.4 s or more, alcohol excess, 180° turn of six or more steps, Mini-Mental State Examination score of 10 or less (0.75 if MMSE score ≥10 and ≤17; 0.5 if MMSE score ≥18 and ≤20, 0.25 for scores ≥20 and ≤24), clock drawing test if unable or fail to draw, functional independence measure of 104 or less, registered blind, over or underweight and presence of pressure sores. Since those unable to complete cognitive [13] or performance-based measures [14] have a worse outcome, inability to complete each test also counted as a deficit. Each individual’s deficit points were then summed and divided by the total number of deficits considered, here 40, to yield a FI with theoretical range 0–1. Higher values indicated a greater number of problems, and hence greater frailty [12].

Outcomes

Since the aim of this unit was to treat, rehabilitate and discharge patients within 28 days, the following outcomes were defined:

- Good outcome: discharged to original residence within 28 days.
- Intermediate outcome: discharged to original residence but length of stay more than 28 days.
- Poor outcome: new care home placement or inpatient mortality.

Twenty-eight days readmission rates and inpatient mortality were determined for all patients. Mortality data were also collected on all patients for 1 year following completion of recruitment (hence up to 2 years after enrolment).

Ethics

The project details were discussed with local research ethics committee. Since all information was collected as part of routine care, additional consent was not sought.

Analytical approach

Comparisons were made according to quality of patient outcome and mortality. Bivariate analyses with patient outcome were made using ANOVA for continuous variables and Chi-square for categorical variables. Multivariate analyses were conducted using ordinal logistic regression for patient outcome. Logistic regression estimates change in odds with a unit change in the explanatory variable. For logistic regression, the FI (0–1) was multiplied by 10 to give a possible range of 0–10. For the purpose of interpreting odds ratios (ORs) and hazard ratios (HRs), this defines a meaningful difference in FI (that used as a per unit change in the analyses) of 0.1 using the original scale. For comparability the same scale was used for the Cox regression to investigate associations with mortality. To aid interpretation, all plots were made using the original FI scale of 0–1. For the Kaplan–Meier survival curve, the FI was divided into low (0–0.25), medium (0.251–0.4) and high (>0.4) groups. These cut-offs were not arbitrary. A FI of 0.25 has been proposed as the demarcation between ‘fitness’ and ‘frailty’ in community-dwelling older people [15]. FI of 0.4 and above, on the other hand, describe older people who are completely dependent on others for activities of daily living and have a significantly higher risk of death and institutionalisation over 5 years of follow-up [16]. Adjustment was made for age, sex and co-morbidity. Analyses were conducted using STATA (v10).

Results

The mean age of the 265 patients was 82.6 years, and 60% were female. Prior to admission, 97% were living in their own homes and 62.6% living alone. Eight-two per cent of
patients had been receiving either informal and/or formal support. Rehabilitation outcomes were as follows; mean Barthel index (BI) was 17 (±2.7) 2 weeks prior to admission, 10 (±4.3) on admission (n = 265) and 15.7 (±3.9) on discharge (n = 229). Seventy-eight per cent of patients were discharged to their own homes. The FI was normally distributed around a mean value of 0.34 (0.09) with a submaximal limit of 0.575.

FI value was strongly associated with worsening patient outcome (P < 0.001) (Table 1) and was a predictor of poor functional gain (measured by change in BI score) (P < 0.001). Chronological age, burden of co-morbidity, polypharmacy and C-reactive protein showed no significant association with outcomes (Table 1). Further tests for trends confirmed no statistical significance for these measures. On the other hand, serum albumin levels and markers of cognitive and functional status were each significantly associated with patient outcome.

A Lowess smoothing curve shows the inverse association between good outcome and FI and suggests FI discriminates better at the lower end of the scale (Figure 1a).

After adjustment for age, sex, co-morbidity and albumin, the OR of intermediate and poor outcome relative to a good outcome was 4.42 (95% CI = 3.05, 6.41; P < 0.001) per unit increase in FI.

In terms of survival, the Kaplan–Meier plot shows a steady reduction in longevity with greater FI (Figure 1b). Cox regression found that, after adjustment for age, sex, co-morbidity and albumin, the HR was 1.63 (95% CI = 1.29, 2.06; P < 0.001) per unit increase in FI. This represents a difference in HR of 7.87 over the 95% range of FI scores. Multivariable analyses were repeated with adjustment for pre-admission BI. This had no material impact on the associations reported above.

### Discussion

In this consecutive patient series from an acute geriatric rehabilitation ward, frailty status was strongly associated with both quality of patient outcome and mortality. In contrast, measures that may currently be used pragmatically to

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**Table 1. Baseline characteristics according to patient outcome**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Good, n = 128</th>
<th>Intermediate, n = 74</th>
<th>Poor, n = 63</th>
<th>Significance (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>82.2 (8.3)</td>
<td>82.3 (9.3)</td>
<td>83.5 (8.5)</td>
<td>0.650</td>
</tr>
<tr>
<td>Gender (females) (%)</td>
<td>74 (57.8)</td>
<td>49 (66.2)</td>
<td>36 (57.1)</td>
<td>0.436</td>
</tr>
<tr>
<td>Living in own house (%)</td>
<td>126 (49.2)</td>
<td>70 (27.3)</td>
<td>60 (23.4)</td>
<td>0.315</td>
</tr>
<tr>
<td>Albumin (gm/l)</td>
<td>38.6 (5.3)</td>
<td>38.8 (4.9)</td>
<td>35.8 (5.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>C-reactive protein (mg/l)</td>
<td>54.2 (74.0)</td>
<td>64.6 (87.4)</td>
<td>65.8 (77.7)</td>
<td>0.527</td>
</tr>
<tr>
<td>Number of admissions in preceding 12 months</td>
<td>0.81 (1.37)</td>
<td>0.93 (1.65)</td>
<td>0.79 (1.22)</td>
<td>0.807</td>
</tr>
<tr>
<td>Charlson co-morbidity index</td>
<td>1.99 (1.6)</td>
<td>2.23 (1.9)</td>
<td>2.29 (1.8)</td>
<td>0.456</td>
</tr>
<tr>
<td>Barthel index</td>
<td>12.3 (3.8)</td>
<td>8.9 (3.1)</td>
<td>6.8 (3.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mini-Mental State Examination</td>
<td>23.1 (4.4)</td>
<td>21.4 (5.5)</td>
<td>19.8 (5.1)</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td>Clock drawing (passed) (%)</td>
<td>66 (61)</td>
<td>31 (29)</td>
<td>11 (10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Functional independence measure</td>
<td>93.7 (15.1)</td>
<td>80.2 (15.7)</td>
<td>67.8 (18.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Polypharmacy (≥5 drugs) (%)</td>
<td>88 (49.5)</td>
<td>50 (28.0)</td>
<td>40 (22.5)</td>
<td>0.765</td>
</tr>
<tr>
<td>Hand grip (kg)</td>
<td>35.9 (18.5)</td>
<td>34.4 (15.7)</td>
<td>29.8 (11.7)</td>
<td>0.221</td>
</tr>
<tr>
<td>180° turn (steps)</td>
<td>7.4 (2.5)</td>
<td>8.2 (1.8)</td>
<td>10.4 (3.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Frailty index</td>
<td>0.29 (0.09)</td>
<td>0.37 (0.07)</td>
<td>0.40 (0.73)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Figure 1.** (A) Lowess smoothing plot of quality of patient outcome according to FI. (B) Survival plot showing mortality progression over time in patients according to FI scores: low (0–0.25), medium (0.251–0.4), high (>0.4).
consider patients‘ suitability for active rehabilitation (including chronological age, burden of co-morbidity, polypharmacy and some biomarkers of illness severity) showed no significant association with outcomes. Our data are among the first demonstrating the association of frailty with rehabilitation outcomes.

The mathematical properties of the FI are informative and it facilitates clinical contextualisation of our cohort. In epidemiological samples, the FI tends to have a gamma distribution; this is a reflection of the heterogeneity in health status of older people in the community [17]. We describe a clinical sample with comparatively more high scorers and the normal distribution of FI scores for our patients indicates a more homogenous (in this case, more vulnerable) group [17]. The FI of patients on admission to the rehabilitation unit ($\bar{x} = 0.34$) has been correlated with the clinical descriptor ‘moderately frail‘ [16]. No patient in our cohort had FI above 0.575 but the maximum value of the FI in epidemiological samples that have included institutionalised and palliatively managed patients is 0.67 [18]. This seems clinically coherent since the most dependent patients and those who were terminally ill were not eligible for admission to this acute rehabilitation unit. Very few poor outcomes or deaths occurred below FI of 0.25, with virtually none of either occurring below FI 0.2. Again, this is concordant with the previously proposed cut-off between ‘fitness‘ and ‘frailty‘ of 0.25 [16].

Our study has certain strengths. We achieved complete follow-up for inpatient outcomes and mortality up to 2 years after enrolment. Frailty was measured for all participants at baseline and assessed using a comprehensive and standard battery of tests. A wide range of risk factors and confounders were available to inform the analysis. We also acknowledge methodological weaknesses. Patients were recruited from one ward at a single hospital site. However, the demographic descriptors, functional status and outcomes for this cohort seem comparable with those for other rehabilitation units [5, 19]. Though the sample size was small, the associations found were strong and highly unlikely to be chance effects. Perhaps the major limitation of this study relates to the variables used to derive the FI. We recognise that some measures, such as grip strength and the FIM, are not routinely collected in the acute sector, particularly for older people not under geriatrician-led care. This limits the clinical utility of the FI described. However, since FI can be constructed from different numbers and types of deficits, a valid measure of frailty status can be derived from information routinely collected in the assessment of an older person [20]. The reliability and clinical utility of an FI derived from CGA is currently being investigated in both its originating setting (Halifax, Nova Scotia) and by our research group in Wales.

Though frail older patients were more likely to have poor outcomes in this cohort, frailty status should not be used as justification for therapeutic nihilism. Complex interventions, such as optimisation of nutrition, better education and exercise (interventions that may modify the accumulation of deficits across many systems), have the potential to delay the onset of frailty [21]. While the evidence regarding the impact of such interventions in hospitalised patients with established frailty is less clear cut [22], exercise does seem to be a safe intervention for all older people, resulting in functional improvement even for those at the frailer end of the health status spectrum [23]. Whether frail older inpatients would benefit from longer periods of rehabilitation in units designed to offer tailored exercise programmes and nutritional support should be the focus of further enquiries.

The FI is not intended to replace clinical judgement and expertise. Geriatricians considering patients‘ suitability for rehabilitation are always likely to err on the side of beneficent interventionism. However, the precise quantification of health status afforded by the FI may help us understand why our interventions work and for whom they are most successful. This may augment the risk stratification of vulnerable older people, improving the effectiveness of care in the acute sector.

Predictors of adverse outcomes

Key points

- Comprehensive geriatric assessment and multidisciplinary rehabilitation are of proven benefit in management of older inpatients.
- The identification of patients who will do well with rehabilitation has lacked a strong evidence base.
- Age, gender and co-morbidity showed no significant association with outcome in patients admitted to an acute rehabilitation ward.
- Frailty status measured by an index of accumulated deficits was significantly associated with adverse outcome, including death.
- The FI may have clinical utility, augmenting clinical judgment in the management of older inpatients.

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Authors‘ contributions

I.S., data collection, wrote first draft of manuscript. J.G., data analysis and interpretation. K.D. and A.J., study design. E.M.P.E., data interpretation. R.E.H., study design and data interpretation. All authors contributed to the writing of the paper and approve the final version.

Conflicts of interest

None declared.
Restriction in participation in leisure activities after joint replacement: an exploratory study

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